

Now that international sanctions on Libya have been lifted, Muammar Gaddafi is inviting outsiders to help create a "northern star" of science and technology in Africa

From Pariah to Science Powerhouse?

TRIPOLI—When Mustafa Eteer, a doctor born in Libya, returned from Canada to visit his mother in this breezy Mediterranean city 4 years ago, he went through a life-changing experience. To his shock and dismay, his mother, who had been hospitalized for a minor illness, died of infections that would have been easily prevented in the West. The public health failure was "not a question of money," says Eteer. Oil revenue has provided Libyans the highest per capita income on the continent, even during the 12 years when the country was under international sanctions for its support of terrorism. Rather, he says, the isolation led to "a lack of knowledge and expertise," which in turn resulted in unnecessary suffering. Eteer vowed to bring modern medical science to Libya—although at the time, he had no idea how he would do it.

Today, thanks to a new drive to boost science by the nation's longtime ruler Colonel Muammar Gaddafi and the lifting of the last of the sanctions in 2004, Eteer may have a chance to realize his dream. He is overseeing the construction of a \$100 million medical science complex on the outskirts of Tripoli that is being held up as an example of the nation's commitment to knowledge. The aim of the Center for Infectious Disease Control in Africa (CIDCA) is grander than Eteer's initial vision: Gaddafi wants it to tackle disease not just in Libya but throughout Africa. However, a dark shadow still hangs over this project and Libya's other scientific aspirations: With the government's acquiescence, a Libyan court has sentenced to death a group of foreign medics on conspiracy charges that outside experts say are based on bogus science (see sidebar on p. 184). The case could be a big impediment to enticing foreign scientists to work here.

The timing could not be worse for Libya's ambitions. As it seeks to dispel old ghosts, the country has embraced a goal of becoming a nexus of scientific and technical collaboration. CIDCA is just the first tangible feature of this vision. Gaddafi began setting the change in motion when he announced his abandonment of weapons of mass destruction (see p. 185) and agreed to pay billions of dollars in compensation for alleged terrorist attacks. Now, to the delight of Libya's academic community, Gaddafi is trying to position Libya as a leading light for the rest of

Africa, in part by providing centers of scientific and educational excellence, including a new observatory for astronomers. Bankrolling these ventures is the Gaddafi Foundation, a huge private fund of undisclosed value created by the Libyan ruler and directed by his son Saif.

"The sanctions killed Libyan science," says Ali Al-Hamdy, an ecologist who directed his country's Marine Biology Center until last



Elite site. The campus of Libya's Center for Infectious Disease Control in Africa boasts tennis courts and irrigated landscaping.

year. "It was nearly impossible to go to conferences, publish in journals, or get equipment. But now, everything is possible."

A CDC for Africa

Beneath the vaulted arcades of the European-styled boutiques in Tripoli's Green Square, immigrant workers sweep up trash in preparation for a state ceremony. Most laborers like these are here illegally, having crossed the dangerous expanse of the Sahara to escape violence and poverty in Sudan, Chad, Niger, and farther south. With them comes the specter of diseases that Libya has until now largely escaped, such as AIDS. Libya's new focus on pan-African diseases is therefore built in part on enlightened self-interest.

"The Libyans usually say they have no AIDS," says Vittorio Colizzi, a molecular pathologist at Tor Vergata University in Rome who has collaborated for several years with Libyan epidemiologists, "but it has definitely been here for years and is increasing." Others

agree that the risk is real. "All of northern Africa has the right ingredients for an AIDS epidemic, including poverty, civil wars, and large refugee populations," says Mark Kline, a virologist who directs the International Pediatric AIDS Initiative at Baylor College of Medicine in Houston, Texas. There's no reason to think Libya will be exempt. But gauging the problem is difficult, he says, because the region falls into "a real hole in terms of epidemiological data."

Colizzi and Massimo Amicosante, a biologist also at Tor Vergata, are here to start plugging that hole. They are meeting with Eteer to finalize an exchange program that will get Italian and Libyan disease researchers working together. The Italian government is an eager partner: It hopes for better disease prevention among the tens of thousands of sub-Saharan refugees each year who use Libya as the departure point on their way to Europe.

Unruffled by Tripoli's fierce traffic, Eteer offers to take the Italian researchers—and *Science*—on a tour of the planned CIDCA site, beginning with a drive through the city's scrubby and desolate out-

skirts. After arriving, we slip through a gate in the barbed-wire-crested wall that surrounds the CIDCA compound and enter a different world. With the help of constantly running sprinklers, lush vegetation sprouts between the tennis courts, guesthouses, and other white-washed buildings. Eteer hopes such amenities, all paid from the deep pockets of the Gaddafi Foundation, will help entice Western disease researchers to work here.

In the main administration building, offices are filled with plastic-wrapped chairs and tables like gifts waiting to be opened. "I want the best scientists in the world to come work here, side by side with Libyans," says Eteer, with a doctor's reassuring smile. Drawing comparisons with the Centers for Disease Control and Prevention (CDC) in Atlanta, Georgia, he envisions Tripoli as the focal point of a collaborative network. But at least initially, the scope of the Libyan institute will be narrower: It will focus on Africa's three big killers, namely AIDS, malaria, and tuberculosis.

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No mirage. Gaddafi appears as hero in his own "Epic of the desert," a poster about a massive water project to supply coastal cities.

Although he does not expect the last bulldozer to leave the site until 2007, Eteer is already seeking a research director. Initially, he says, there will be room for 100 scientists doing a mixture of basic molecular research and epidemiology. To generate steady income, a diagnostic laboratory will handle all of Libya's blood samples, which are currently shipped abroad for testing, amounting to \$10 million of potential income annually. There are also plans to build a factory on site to produce generic drugs for the three diseases. Competition for positions at CIDCA will be "open, like any Western institute," but Eteer adds that the emphasis will be on building collaborations with Africans who "stand to gain the most" from Western expertise.

"It is a grand plan, and badly needed," says Bashir Allaghi, one of Gaddafi's personal physicians, who sits on the board of the Gaddafi Foundation. "We Libyans are open to the world. We are hungry for contact."

Outsiders seem optimistic but wary. The center could be a windfall for "the massive shortage of expertise in Africa," says Kevin de Cock, director of CDC's Kenya field station. But without "very careful diplomacy," he warns, it could also be a flop. One potential pitfall is its location. "Libya is far from sub-Saharan Africa, where these diseases are at their worst, so they will have to build satellite centers for fieldwork," he says. And Gaddafi's pronouncements that Libya "speaks for Africa" have caused tension. De Cock is surprised to have heard about CIDCA

only recently. "Are they going to collaborate or compete?" he wonders.

Perhaps the biggest surprise is that "executive control" of CIDCA will be handed over to a Westerner. "I don't want a Libyan to be in charge," says Eteer. "Only an outsider can be free from all the political pressures here." Allaghi says the Gaddafi Foundation backs the plan. But one skeptic is Colizzi. "Will the Libyans really put a \$100 million facility in Western hands? No way." Another question is who would be willing to take up the post if Libya carries out the death sentence it imposed last year on a group of foreign medics. The opinions of many likely candidates, such as Hans Wigzell, director of medical research at the Karolinska Institute in Stockholm, Sweden, who calls the medics



Prodigal son. Mustafa Eteer returned from Canada to help build Libya's disease research center.

"Libya's scapegoats," are already hardening.

In spite of such doubts, Colizzi believes Libya's ambitions to bring modern medical science to Africa are genuine. "They do want to make this work," he says. "The question is if they will really let science be independent of politics."

Getting started

CIDCA is a sign of things to come for Libya's academic community, according to Abdusalam Al-Gallali, Libya's new secretary of higher education. "We now have all the money we could need," he says, "and our priority is to improve the quality of work and teaching."

Libya now claims to have set a high standard for the rest of the Arab world. Unusual for a Muslim nation, there appears to be gender equality in higher education: 50% of students are female, according to Al-Gallali, and the highest academic position—chancellor of El-Fateh University in Tripoli—is occupied by a woman. He also claims that Libya is second only to Canada in per capita attendance at university, where postsecondary education is estimated to be just over 50%.

Libya hopes to employ these highly trained young people and keep them from emigrating, says Yusef Mabosut, a U.S.-trained microbiologist who was chancellor of El-Fateh until 2000. For some fields, such as geology and engineering, there seems to be endless room for growth. Beyond the oil industry, Gaddafi's \$28 billion "Great Man-

made River Project,” called the largest public works project in the world by the United Nations Educational, Scientific, and Cultural Organization, has employed thousands to pipe water from deep beneath the Sahara to Libya’s coastal cities—and it’s far from finished. But for students in other fields, the prospects look grim. This is one reason why the government is ramping up funding for new scientific projects such as CIDCA. Among others to benefit are the country’s small community of astronomers; they are getting a new observatory.

Last year Gaddafi personally contacted the French electronics company Sagem to buy a \$13 million telescope, making up for a lost purchase from Germany that fell through during the embargo. Gaddafi is “passionate” about astronomy, says François Querci, an astrophysicist at the Observatoire Midi-Pyrénées in Toulouse, France. Plans call for the telescope to be set up in Libya’s southeastern deserts, although abundant landmines—a legacy of war with neighboring Chad—could pose a problem. Querci was there in February to meet with the country’s top astronomer, Hadi Gashut, to discuss Libyan participation in an embryonic network of observatories in Muslim countries. “Libya is taking a leadership role,” says Querci.

Evidence Overruled: Medics on Death Row

TRIPOLI—The toll of the past few years shows on Zdravko Georgiev’s ashen face. He was working as a doctor in southern Libya in 1999 when he heard that his wife Kristiyana—a nurse in the northern town of Benghazi and, like him, a Bulgarian—had been arrested. He rushed back to Benghazi and immediately contacted the police for information. After several days without word of his wife, he was arrested, too. And then, he says, the nightmare began: Torture without explanation, police interrogations, and accusations of conspiracy.

After holding them for a year without access to lawyers or the outside world, prosecutors charged Georgiev, his wife, three other Bulgarian nurses, and a Palestinian doctor at the Benghazi hospital with acts of bioterrorism. The Libyan government accused the foreign medics of deliberately infecting children under their care with a strain of genetically engineered HIV. By then, hundreds of children at Benghazi’s Al-Fateh hospital were found to have been mysteriously infected with HIV, and many had already died of AIDS-related illnesses. Today, the medics deny any wrongdoing, although they earlier gave confessions which they—and doctors who have been allowed to examine them—say were extracted under torture.

Protests from abroad prompted Libya to invite European scientists to come to Benghazi and study the outbreak. The team, led by Vittorio Colizzi, a molecular pathologist at Tor Vergata University in Rome, and Luc Montagnier, a virologist at the Pasteur Institute in Paris and co-discoverer of HIV, concluded that the evidence was overwhelmingly in favor of the medics’ innocence. They put the blame for the infections on negligent



With a 2-meter-diameter mirror, the Libyan telescope will be modest by world standards, but it will be perfect for studying variable stars that require continuous observation, says Michael Bode, an astrophysicist at Liverpool John Moores University in the United Kingdom. It will also be valuable, says Querci, as the only view from northern Africa, where the skies are far clearer than those over Europe along the same longitude. Observations are expected to begin in early 2006.

Meanwhile, for Libyan archaeology the lifting of the embargo looks like a mixed

blessing. The government, anticipating a boom in tourism, has renewed interest in researching and preserving the region’s 10,000 years of human settlement. That should translate to more archaeology jobs, says Sa’ad Abdul Aziz, director of the Germa Museum in southern Libya, who coordinates archaeological research for Libya’s Department of Antiquities. But at the same time, development of oil exploration, roads, and pipelines also may skyrocket. And particu-

larly for the most vulnerable and least studied of Libya’s archaeological heritage—such as the ancient rock engravings that can be found on boulders throughout the southern deserts—this spells trouble. With so much of Libya’s income dependent on petroleum, it seems unlikely that archaeology will be given higher priority.

But Aziz is optimistic. “We have been very isolated,” he says, “but that time is over. Everyone just wants to start the work.”

—JOHN BOHANNON

John Bohannon is a science writer based in Berlin.



End of the line. Six foreign medical workers in Libya have been sentenced to death on improbable charges of bioconspiracy; a final decision is pending.

practices hospital-wide. But this opinion was rejected. To the shock of international observers, the Libyan court found the medics guilty last year and sentenced them to death by firing squad. Libya’s Supreme Court will announce its verdict on the medics’ final appeal on 31 May. Gaddafi has said he believes they are guilty.

Western observers condemn the Libyan proceedings. “This was a betrayal to my profession,” fumes Hani Shennib, a Libya-born professor of surgery at McGill University in Montreal, Canada, who is coordinating relief efforts for the infected children.

The timing could not be worse for Libya’s efforts to shake its reputation as a lawless pariah state. The future of at least one major new Libyan science initiative—a disease research center near Tripoli—hangs on the outcome of this case (see main text). Outsiders see it as a test of whether Libya is truly ready to host such an institution. “Who would want to come work in a country where science and logic are not respected?” asks Hans Wigzell, director of medical research at the Karolinska Institute in Stockholm, Sweden. Wigzell was one of the authors of an open letter last year,

Agencies Plan Exchange With Libya's Former Weaponers

U.S. officials are trying to involve Libya's weapons experts in outside collaborative projects. One potential hitch: The Libyans want to keep working on missiles

After months of delicate planning, the United States is embarking on a groundbreaking effort to bring Libya's former weapons researchers in from the cold. The initiative is expected to include exchange programs to foster scientific and commercial cooperation between Western and Libyan scientists and a "sister" link between Lawrence Livermore National Laboratory in Livermore, California, and the Tajoura Nuclear Research Centre in Tripoli, Libya, which had been the nerve center of Libya's nuclear weapons program.

"The steps being taken to engage the [former weapons] scientists are an important make-or-break element of Libya's reattachment to the international community,"



Physical evidence. A U.S. guard in Oak Ridge, Tennessee, stands watch over contraband nuclear materials Libya surrendered last year.

says Rose Gottemoeller, an expert on nuclear nonproliferation at the Carnegie Endowment for International Peace in Washington, D.C. "If key elites such as the

signed by 28 scientists from eight countries, calling on Gaddafi to recognize the scientific evidence and intervene on the medics' behalf.

It seems as if "science itself has been on trial here, and lost," says Colizzi, who was called as an expert witness by the Libyan court. Colizzi and Montagnier studied the outbreak in Benghazi between 2002 and 2003. "We were supposed to have free access to all the materials and data to make an objective study," says Colizzi, "but in fact hospital officials tried to block us at every step."

The first surprise came when they asked to see the "smoking gun" in the case, a pair of vials allegedly found in the home of one of the Bulgarian nurses. In the court, a Libyan doctor presented the vials along with the results of a Western blot—a test using antibodies to detect the presence of a particular protein—which he said "proved" that the HIV outbreak originated from stocks kept secretly by the medics. Upon seeing the blot, Montagnier says, he concluded "it just looked like background noise." He proposed to test the vials with the more sensitive polymerase chain reaction to look for specific RNA sequences of the virus. But officials never made the vials available.

In spite of such hindrances, Colizzi and Montagnier were able to obtain blood samples and medical records from the children, examine the hospital, and interview its staff. It soon became apparent, says Colizzi, that "this is a classic nosocomial infection" in which tainted blood is accidentally passed between patients through poor hygiene practices, such as the reuse of disposable syringes and catheters, insufficient sterilization of instruments, and a general lack of quarantine between patients. The most compelling evidence of contamination they found, according to Colizzi, was the presence of other viruses in the children's blood, including several strains of hepatitis C. "This is extremely unusual for children," says Colizzi, "but is easily explained if there have been multiple accidental contaminations in the hospital."

Colizzi and Montagnier maintain that these results alone should be enough to exonerate the accused, but Colizzi thinks another piece of evi-

scientists" don't participate, she warns, "the danger of backsliding and failure becomes strong." Building an esprit de corps with Libyan researchers could have a broader political payoff as well: It "can only be seen as a good deed in a time that most Muslim countries don't look too kindly on us," says Jack Boureston, managing director of First-Watch International, a nonproliferation think tank in Monterey, California.

In contrast to the U.S. government's spotlighting of recent initiatives to find civilian work for former weaponers in Iraq, few details about the Libya effort have been released. The U.S. State Department has asked U.S. officials and scientists in the U.S. national laboratories not to speak with the press about the Libya initiative; nonetheless, several agreed to speak with *Science*, but only on condition of anonymity. U.K. officials also involved in the effort declined to comment.

This caution, *Science* has learned, derives from a concern about ongoing, intricate negotiations with segments of Libya's former weapons community. Libyan officials apparently have asked that the evolving initiative not yet be publicized. "One particular concern" from the U.S. side, says a senior Bush Administration official, is that Libya's ballistic missile

dence puts their innocence "beyond doubt." According to the hospital medical records, some of the children became infected with HIV before the medics even started working at the hospital. And in one case, a child of HIV-negative parents became infected at birth in the hospital, long after the medics had been arrested. According to the prosecution, the dates are errors in the hospital's record keeping.

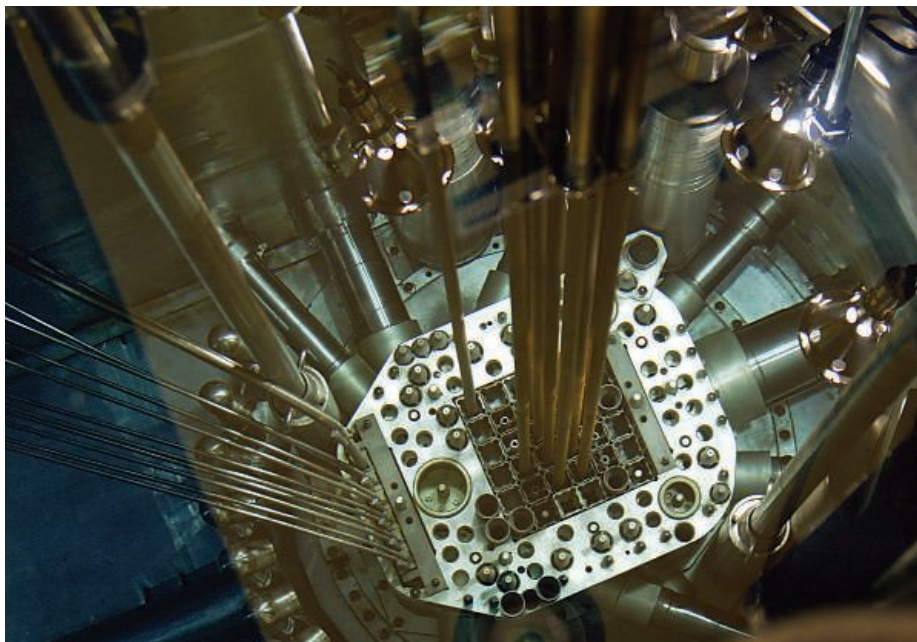
The prosecutors have had some difficulty, however, sustaining the charge that the strain of HIV was engineered in a lab. "They jumped to this conclusion," says Colizzi, "because this particular HIV strain did not appear in GenBank," the database of genetic sequences maintained by the U.S. National Institutes of Health in Bethesda, Maryland. The Libyan government backed away from the claim in 2002, referring to the case as one of homicide rather than bioterrorism.

In 2003, in the presence of international observers, including ambassadors from 13 countries, Colizzi and Montagnier presented their findings to the Libyan court. Five Libyan doctors at the same time accused the Europeans of being "unscientific" because of inconsistencies in some of the clinical data. Colizzi responds that the source of the data was the hospital itself, and that if the disputed data are removed, the case against the Bulgarians still doesn't hold up. But the Libyan judges were not persuaded: In May 2004, they declared the medics guilty. Georgiev alone was released with a suspended sentence, perhaps in light of the fact that he had not even been working at the hospital. He now lives within the protection of the Bulgarian embassy in Tripoli, where he met with *Science*.

Since the sentencing, the Libyan government has said that the case might be "reconsidered" if compensation is paid—a sum of more than \$5.7 billion was suggested—and if the British government is willing to release a Libyan accused of the 1988 bombing of a jet over Lockerbie, Scotland. "Scientific thinking has no more role to play in this anymore," says Colizzi. "It's completely political now. Or perhaps it always was."

—J.B.

researchers “want to keep working on missiles. Obviously that’s a problem,” he says. According to a nonproliferation official at the U.S. Department of Energy (DOE), the Libyan government claims to have 4000 missile scientists and technicians, including 500 with advanced degrees—the largest subset of former weaponeers being courted for exchanges.



Hot source. A research reactor at the Tajoura nuclear facility was used to make weapons-grade uranium.

Libya’s rapprochement with the West began after it announced on 19 December 2003 that it would disband its R&D on non-conventional weapons and eliminate existing stockpiles. Since then, investigators from the U.K. and U.S. governments and the International Atomic Energy Agency (IAEA) in Vienna, Austria, have assembled an increasingly detailed picture of the once-clandestine programs.

Libya’s nuclear R&D effort was more ambitious than suspected, but analysts believe it was at least several years away from a bomb. An IAEA report last year noted that in the 1980s uranium targets were irradiated in Tajoura’s Soviet-made, 10-megawatt research reactor. Tiny quantities of plutonium were separated from at least two targets at a radiochemical laboratory, although investigators now believe that Libya focused solely on a uranium bomb. In March 2004, the IAEA report notes, about 13 kilograms of fissile uranium-235 were flown from Tajoura, on the eastern edge of Tripoli, to Russia for blending into power plant fuel. When it came clean in late 2003, Libya revealed a further 11 nuclear sites and 15 weapons-related sites.

One particularly disturbing facet, experts say, is that Libya readily obtained

materiel and know-how through a global nuclear black market, primarily the network run by the father of Pakistan’s bomb, Abdul Qadeer Khan. “In our estimation there was not a lot of indigenous talent. [Libya] procured the equipment and bought the recipes,” says the Administration official. The IAEA report recounts how in late 2000 Libya had outfitted a pilot

enrichment facility with three cascades of centrifuges based on an advanced design from Pakistan, before mothballing the equipment 2 years later for security reasons. In January 2004, a U.S.-U.K. team shipped 25,000 kilograms of Libya’s most sensitive items, including centrifuge parts and uranium hexafluoride—the gas fed into centrifuges for concentration—as well as weapons designs to Oak Ridge, Tennessee, for analysis and destruction.

According to Libya, 800 nuclear specialists, including 140 with advanced degrees, were involved in the program. “Right now we have no way to vet those numbers,” says the Administration official. U.S. officials note that some senior Libyan weaponeers were educated in Europe, particularly the United Kingdom, or in the United States before sanctions were imposed on Libya in the 1980s.

Although Libya wasn’t close to going nuclear, it produced chemical weapons and was accused by Chad of using mustard gas against its forces during a border conflict in 1987. (Libya has denied the allegation.) In March 2004, Libyan officials declared to international investigators that the country had stockpiled 23 tons of mustard gas at its al-Rabta facility, which Italy is now helping

convert to a pharmaceutical plant. Libya says it has 120 former chemical weapons workers but just 12 with advanced degrees, according to the DOE official.

“The Libyan nuclear and chemical scientific core is certainly smaller and less seasoned than that of other rogue regimes such as Iraq,” says Sammy Salama, a Middle East expert at the Monterey Institute’s Center for Nonproliferation Studies in California. However, he says, their “relevant firsthand experience”—operating the Tajoura reactor and cooking up chemical weapons—“makes Libyan scientists desirable for other rogue regimes that may have WMD aspirations.”

Libya’s ballistic missile program, meanwhile, was centered on relatively primitive Scud designs. “Their missile work isn’t thought to be all that great,” says a U.S. specialist. The Administration official insists that “carrots exist” to get researchers to abandon missile R&D; he declined to elaborate. Inspectors are still probing whether Libya had more than a passing interest in biological weapons.

The U.S. State Department has taken the lead in organizing workshops between U.S. and U.K. experts and Libyan counterparts. The first two meetings, last October and December in Tripoli, explored potential collaborations on a hydrological and geochemical database, an environmental monitoring lab, technologies for water purification, and the production of medical radioisotopes.

One initiative gaining traction is a sister lab agreement between Livermore and Tajoura. Although not finalized when *Science* went to press, the arrangement would resemble a successful DOE program for Russian nuclear scientists begun after the Soviet Union’s dissolution in 1991. Joint research could include, for example, neutron activation analysis for materials science using Tajoura’s research reactor and associated labs. DOE’s National Nuclear Security Administration also aims to help convert the reactor from using highly enriched to low-enriched uranium fuel.

In the meantime, U.S. officials are organizing a reciprocal visit later this spring of a Libyan delegation. The itinerary would include Livermore and Sandia National Laboratories and sites where Cold War-era nuclear weapons facilities have been dismantled—possibly Hanford in Washington state and Savannah River in South Carolina.

Unlike the engagement effort in Iraq, U.S. officials expect oil-rich Libya to bring significant resources to the table. “They don’t need our money; they need ideas,” says the Administration official. “Their main priority is partnership.” It’s a fragile relationship that’s just beginning to blossom.

—RICHARD STONE

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